EFFECTS OF INTENSIVE FOREST MANAGEMENT ON AMPHIBIANS AND REPTILES OF VANCOUVER ISLAND

PROBLEM ANALYSIS

INTEGRATED WILDLIFE INTENSIVE FORESTRY RESEARCH

BC
Ministry of Forests

A cooperative project between the Ministries of Environment and Forests

EFFECTS OF INTENSIVE FOREST MANAGEMENT ON AMPHIBIANS AND REPTILES OF VANCOUVER ISLAND

Problem Analysis

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Compiled

1981

Published

April 1986

This Publication is IWIFR-23

B.C. Ministry of Forests, Research Branch EP 916
B.C. Ministry of Environment, Wildlife Bulletin B-40

This project is jointly funded and directed by the
B.C. Ministries of Environment and Forests

Copies of this report may be obtained, depending on supply, from:

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Citation:

Sadoway, K.L. 1986. Effects of intensive forest management on amphibians and reptiles of Vancouver Island: problem analysis. Research, B.C. Ministries of Environment and Forests. IWIFR-23. Victoria, B.C.

PREFACE

This publication is one of three companion publications resulting from the problem analysis on "The effects of intensive forest management on non-ungulate wildlife of Vancouver Island". Non-ungulate species include all amphibian, reptile, bird, and mammal (excluding deer and elk), species that occur on Vancouver Island.

Several factors, in conjunction with the demands imposed by an increase in public awareness, are responsible for the initial problem analysis proposal. First, while management efforts on Vancouver Island will certainly continue to focus on deer and elk, an increasing interest is increasing in other game and nongame species. Second, experience elsewhere indicates that, with the increased concern for the welfare of these species, the demand for their greater protection and management will also increase. Third, it is likely that intensive forest management will affect these species at least as significantly as it has affected deer and elk. Finally, our knowledge of the habitat requirements of these species is very limited.

What is known, though, is that timber harvesting is the major factor affecting species habitats on Vancouver Island. Begun over a century ago, logging has since altered a major portion of the forested land on Vancouver Island. Because the Island has one of the most productive timber producing areas in the province, timber harvesting and its associated intensive forestry practices will certainly continue to play a major role in altering species habitats.

Wildlife management is the responsibility of the Fish and Wildlife Branch (British Columbia Ministry of Environment); the land base on which the wildlife live is primarily under the control of the Ministry of Forests.

The goals of wildlife management in British Columbia are:

1. to maintain the diversity of species representative of the major biophysical zones of the province; and
2. to ensure that within the constraints of land capability and biological limits of each species, wildlife is available in sufficient abundance to meet the recreational and economic needs of society.

To meet these goals, objectives, policies and management prescriptions have been developed and are presented in a series of draft management documents prepared by the Branch.

The Ministry of Forests Act dictates that the Ministry is responsible for planning "...the use of the forest and range resources of the Crown so that the production of timber and forage; the harvesting of timber; the grazing of livestock; and the realization of fisheries, wildlife, water, outdoor recreation and other natural resource values are coordinated and integrated, in consultation and cooperation with other ministries and agencies of the Crown and with the private sector" (Ministry of Forests Act 1978, Section 4c).

Implementation of these two ministerial mandates is the guiding forces influencing the interactive management of forests and wildlife.

The OBJECTIVE of this problem analysis is:

> TO IDENTIFY RESEARCH QUESTIONS AND PRIORITIES REGARDING THE HABITAT REQUIREMENTS AND THE EFFECTS OF INTENSIVE FOREST MANAGEMENT ON THE NON-UNGULATE WILDLIFE OF VANCOUVER ISLAND.

To facilitate the large number of non-ungulate species to be considered in this analysis, species were grouped under three general taxonomic headings: 1) amphibians and reptiles; 2) mammals; and 3) birds. A total of 195 non-ungulate species were considered. Within each group, species were further organized by lifeforms -- an assemblage of species with similar reproductive and feeding strategies (Niemi and Pfanmuller 1979). Organizing species into lifeforms was designed to assist identification of the habitat requirements and effects of intensive forest management common to all, or a majority, of the species in the lifeform. Information on each of the three species groups was compiled, organized and analysed separately. Although this resulted in some differences in format, the topics addressed were the same. These topics include: the problem; wildlife management objectives and policies; species distribution, status, protection, numbers, and habitat requirements; and effects of intensive forest management. Research recommendations, designed to address the information needs identified, conclude each analysis.

ACKNOWLEDGEMENTS

Special thanks are extended to Stan Orchard and Alton Harestad for their helpful suggestions, on-going interest, and the knowledge they willingly contributed throughout this analysis.

Thanks to Neil Dawe, Patrick T. Gregory, Stan Orchard and Alton Harestad for their review of this manuscript and useful comments.

I also wish to acknowledge the Vertabrate Zoology Division of the British Columbia Provincial Museum for the valuable information resource centre they provide. I am grateful for the access I was given to the British Columbia Wildlife Record Scheme and the herpetology library.

Thanks to Rick Ellis, for his support and patience throughout the length of this project; to Cheryl Ward and Louise Gronmyr for typing this manuscript.

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1 INTRODUCTION

Amphibians and reptiles are cryptic animals and generally go unnoticed. Of the 19 amphibians and 18 reptile species known to occur in British Columbia, nine amphibian and seven reptile species are indigenous to Vancouver Island (Appendix 13.1). An additional three amphibian species have been introduced to the Island.

The economic importance of these animals is linked largely to the pet trade. Amphibians are extensively used for biological research and frog legs continue to be a popular gastronomic fare in eastern Canada and the U.S.A. The market demand for snakeskin leather is also increasing.

Ecologically, amphibians are an important food source for a variety of fish, reptiles, birds and mammals. The amphibians' role in controlling forest insect pests has been stated (Pearce and Price 1975); however, the extent of this role and its economic value have not been studied. Reptiles play the role of both predator and prey.

In this analysis on the effects of intensive forest management on amphibians and reptiles, only indigenous species will be discussed in detail. Information on the three introduced amphibian species is limited to species distribution and its potential effects on indigenous species.

2 MANAGEMENT OBJECTIVES

The preliminary management plans developed by the Fish and Wildlife Branch (B.C. Ministry of Environment 1979, 1980) identify four management objectives. They are similar for amphibians and reptiles:

1. Maintain the present diversity and range of amphibian/reptile species.
2. Establish with other agencies and groups reporting systems to better determine both distribution of amphibians/reptiles and trends in their numbers.
3. Restrict the harvesting of species for recreation or commercial use.
4. a. Promote a better public understanding and awareness of amphibians.
   b. Promote a better public understanding and tolerance of reptiles.

3 MANAGEMENT PROGRAMS

Amphibians and reptiles have been and are still low priority and therefore specific management programs will not be established by the Fish and Wildlife Branch (B.C. Ministry of Environment 1979, 1980). Generalized management plans have been projected in order that amphibian and reptile populations will be maintained for the future. These management prescriptions include:

1. bringing amphibians and reptiles under the authority of the Wildlife Act;
2. developing a permit system to monitor harvesting levels; and
3. assisting in the development of a standard reporting system to provide low-level monitoring of amphibian and reptile populations.

4 PROBLEM

Although concern for amphibian and reptile species has increased, the ability to effectively manage the species is limited. Two major reasons are responsible for this. First, public concern has not demanded that there be any action. Second, information concerning species distribution, abundance and habitat needs is incomplete or, in many cases, unknown.

A combination of factors perpetuate this situation:

- traditionally, many reptilian and some amphibian species have been persecuted due to public misunderstanding;
- the cryptic behaviour of the species makes inventory and field observation difficult;
- very little research has been conducted in B.C. due to budget constraints, lack of manpower and general disinterest; the Fish and Wildlife Branch has focussed on high priority wildlife species;
- the majority of research has been conducted in the southern part of the species' distribution; their poikilothermic physiology and the differences in environmental conditions influencing their behaviour in the north and south make extrapolation unreliable (Orchard pers. comm.);

- the majority of research has focussed on physiological studies rather than ecological studies; and
- the economic importance of the species is undefined due to lack of data.

With intensive forestry practices altering much of the Vancouver Island land base, it is important that information concerning species habitat requirements be identified and population trends be recognized in order that necessary information is available when needed.

5 STATUS

The present status of amphibians and reptiles is difficult to assess because inventories have not been conducted. Modification of the habitat has, however, undoubtedly caused an overall decline in the numbers of several species.

In 1980, at a symposium on threatened and endangered species, the status of amphibians and reptiles in British Columbia was presented (MacIntyre and Palermo 1980, Orchard 1980). For the species that occur on Vancouver Island, the red-legged frog (Rana aurora) and the painted turtle (Chrysemys picta) were identified for concern. It was suggested that the red-legged frog be assigned the status of threatened. Habitat destruction and direct competition from introduced species were given as the two factors responsible for their decline (Licht 1971, MacIntyre and Palermo 1980). Competetive exclusion of indigenous amphibian species by introduced species has been documented in some of the sowthwestern states (U.S.A.) (Dumas 1964, Moyle 1973). To what extent this is occurring on the Island and the factors that contribute to the successful dispersal of introduced amphibian species are unknown. The rapid modification of lake margins for real estate and recreational use in the interior of B.C. has also generated concern for the welfare of the painted turtle. These lakeshore margins represent the painted turtle's principal breeding habitat. While these man-made pressures are probably not as prevalent on Vancouver Island, disturbances created by logging and road building along the margins of water bodies will likely produce similar adverse effects.

6 PROTECTION

Amphibians and reptiles are not under the jurisdiction of the current Wildlife Act. This omission is to be rectified when parliament passes the new Act.[1] No amphibians or reptiles have been designated threatened or endangered by the Province; therefore, no species are under the jurisdiction of Section 78 of the present Wildlife Act. At this time, their only protection occurs on the tracts of land that have been designated ecological reserves, federal or provincial parks, or sanctuaries. The riparian and aquatic habitat used by amphibians and reptiles may in some areas be indirectly protected by the Fisheries Act (1979).

7 DISTRIBUTION

There are relatively few distribution records for amphibians and reptiles in B.C.. The cryptic nature of amphibians and reptiles, lack of public interest and a paucity of academic research are principal causes. Information that is available has been provided by a small number of researchers and interested public in the form of specimens or sight records. These are available through the provincial and local museums and academic institutions. Much of this information is presented in the Preliminary Wildlife Plans (B.C. Ministry of Environment 1979, 1980). Scientific literature provides an additional information source.

Amphibian and reptiles species distributions for Vancouver Island are presented in two forms:

1. Based on the scheme adopted by Ellis (1980), species location records were matched to the corresponding biogeoclimatic subzones (Packee 1975, Klinka et al. 1979) within his defined regions for Vancouver Island (Table 1). This provides a biogeoclimatic and latitudinal distribution for each species.

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[1] Prior to publication of this manuscript, the Wildlife Act 1982 has be ratified. Species designated as wildlife are afforded protection under this new Act; the sharptail snake (Contia tenuis) has been so designated.

TABLE 1. Distribution of amphibians and reptiles by region and biogeoclimatic subzone

SPECIES	ALBERNI INLET-QUALICUM TO SOUTH					ALBERNI-QUALICUM TO MUCHALAT INLET-CAMPBELL R					MUCHALAT INLET-CAMPBELL R TO QUATSINO SND-PT McNEILL					QUATSINO SD-PT McNEILL TO NORTH				
	Douglas-fir		Western Hem		Mtn Hem[1]	Douglas-fir[1]		Western Hem		Mtn[2] Hem	Douglas-fir[2]		Western Hem		Mtn Hem	Douglas-fir[1]		Western Hem[1]		Mtn Hem[1]
	Dry	Wet	Dry	Wet		Dry	Wet	Dry	Wet		Dry	Wet	Dry	Wet		Dry	Wet	Dry	Wet	
AMPHIBIANS																				
Northwestern Salamander	x	x	x	x			x		x	x									x	
Long-toed Salamander	x		x			x		x				x	x	x					x	
Cloudeo Salamander	x	x	x	x			x		x											
Oregon Ensatina	x	x				x	x													
Western Redback Salamander	x	x	x	x		x	x	x	x				x						x	
Western Toad	x	x	x	x				x	x	x	x		x						x	
Pacific Treefrog	x	x	x	x			x		x	x	x		x						x	
Reo-legged Frog	x		x	x			x	x		x			x						x	
Roughskin Newt	x	x	x	x			x	x	x	x			x							
Bullfrog	x	x	x																	
Green Frog	x																			
Northern Leopard Frog		x	x																	
REPTILES																				
Painted Turtle	x	x					x					x								
Sharptail Snake	x																			
Western Terrestrial Garter Snake	x	x	x				x							x					x	
Northwestern Garter Snake	x	x	x	x			x	x	x			x		x					x	
Common Garter Snake	x	x	x	x			x	x	x					x					x	
Northern Alligator Lizard	x	x	x																	
Western Skink		x																		

1 subzone or zone not found in this region
2 record location - Forbidden Plateau

2. Tables 2 and 3 summarize this information for the three Biogeoclimatic Zones of Vancouver Island (from Table 1) and also describe the geographical extent of each species.

7.1 Amphibians

Generally, amphibians are found in the five biogeoclimatic subzones found on Vancouver Island (Table 2); however, regional disparities (Table 1) indicate that there are latitudinal restrictions for some species.

Oregon ensatina (Ensatina eschscholtzi) and the western redback salamander (Plethodon vehiculum) are the only two species that have not been found in the Mountain Hemlock Biogeoclimatic Zone. Oregon ensatina and long-toed salamander (Ambystoma macrodactylum) appear to be restricted to the Coastal Douglas-fir Biogeoclimatic Zone.

Of evolutionary and zoogeographic interest is the distribution of clouded salamander (Aneides ferreus). This species is found only on Vancouver Island and some neighbouring islands, but is virtually absent on the B.C. mainland. Its southern distribution is also interrupted in the State of Washington and then it occurs once again in Oregon and California.

The remaining indigenous amphibian species are found throughout Vancouver Island. Species include:

Northwestern Salamander	(Ambystoma gracile)
Roughskin Newt	(Taricha granulosa)
Western Toad	(Bufo boreas)
Pacific Treefrog	(Hyla regilla)
Red-legged Frog	(Rana aurora)

Localized ferral populations of bullfrogs (Rana catesbeiana) and northern leopard frogs (Rana pipiens) have become established on Vancouver Island (Green 1978). Their potential, especially the bullfrog's, for outcompeting and reducing indigenous species is significant (Licht 1971, Green 1978, Schaub and Larson 1978, MacIntyre and Palermo 1980, also see Section 5). The green frog (Rana clamitans) has been reported in the Victoria area as well as at Duncan (Orchard pers. comm.).

TABLE 2. Distribution of amphibians on Vancouver Island

AMPHIBIANS	Douglas-fir Dry	Douglas-fir Wet	Western Hem Dry	Western Hem Wet	Mtn Hem (zone)	Geographic Extent Vancouver Island	Geographic Extent B.C. Mainland
Northwestern Salamander	x	x	x	x	x	all Van Is	coast
Long-toed Salamander	x	x				southeast Van Is	most of B.C.
Clouded Salamander	x	x	x	x	x	Van Is and some neighbouring islands only	
Oregon Ensatina	x	x				southeast half of Van Is	southwest corner
Western Redback Salamander	x	x	x	x		all Van Is	southwest corner
Western Toad	x	x	x	x	x	all Van Is	all over B.C.
Pacific Treefrog	x	x	x	x	x	all Van Is	southeast 1/4 and southwest corner
Red-legged Frog	x	x	x	x	x	all van Is	southwest corner
Roughskin Newt	x	x	x	x	x	all Van Is	north coast and southwest corner
Bullfrog (I)	x	x				Parksville area	southwest corner
Greenfrog (I)	x					Victoria	southwest corner
Northern Leopard Frog (I)		x				Hamilton Swamp near Coombs	southeast corner

I - introduced species

TABLE 3. Distribution of reptiles on Vancouver Island

REPTILES	Douglas fir Dry	Douglas fir Wet	Western Hem Dry	Western Hem Wet	Mtn Hem (zone)	Geographic Extent Vancouver Island	Geographic Extent B.C. Mainland
Painted Turtle	x	x				Patterson Lake, Great Central Lake and area to Victoria	southern 1/3
Sharptail Snake	x					Metchosin area; N & S Pender Is, Sidney, Saltspring, and Galiano Is	
Western Terrestrial Garter Snake	x	x	x	x		throughout Van Is	southern 2/3
Northwestern Garter Snake	x	x	x	x		throughout Van Is	southwest corner
Common Garter Snake	x	x	x	x		throughout Van Is	southern 2/3
Northern Alligator Lizard	x	x	x			southern half of Van Is	southern 1/4
Western Skink		x				Wolf Lake near Courtenay	Kootenays and S Interior

7.2 Reptiles

Reptiles are more restricted in their biogeoclimatic distribution (Table 3) than are amphibians. Although found in both subzones of Douglas-fir and Western Hemlock Biogeoclimatic Zones, their occurrence in the Mountain Hemlock Zone has not been reported.

Reptilian populations appear to be more localized than amphibian populations. Painted turtle (C. picta) populations have been found on Vancouver Island at locations from Great Central Lake and Patterson Lake area to Victoria. Its restricted distribution and the fact that this species is commonly kept as a pet have caused speculation about its indigenous status. Until recently, the distribution of the sharptail snake (Contia tenuis) was believed to be restricted to North and South Pender Island (Orchard 1981). Specimens collected near Metchosin and on Saltspring Island, and observations from Sidney and Galliano Islands suggest its distribution in the southern portion of the Coastal Douglas-fir Biogeoclimatic Zone. The western skink (Eumeces skiltonianus) has been recorded only twice on Vancouver Island in the Wolf Lake area near Courtenay. Neither sighting, however, can be verified since the specimens were not collected or photographed (Orchard pers. comm.).

8 HABITAT REQUIREMENTS

Information identifying the specific habitat requirements for amphibians and reptiles is generally lacking: for the species inhabiting British Columbia or Vancouver Island, it is virtually unknown. However, factors that influence their distribution are documented and are the basis on which their habitat requirements are discussed in this analysis.

8.1 Amphibians

Habitats suitable for amphibians are generally described as damp or humid sites under forest debris and/or adjacent to water bodies or waterways (Appendix 13.2). It is apparent that water is a major component of the animals' habitat. A theoretical model considering body temperature, water, and bioenergetic relations separately, and as a single working unit, indicates that most terrestrial amphibians are dependent to a much greater extent on water relations than on temperature relations (Tracy 1975).

The skin of amphibians is moist and affords them the protection against overheating through evaporation (Noble 1954). However, as the skin is subject to rapid desiccation, few amphibians, other than thick-skinned toads and terrestrial stage newts, survive long periods in a dry atmosphere. Contrary to most amphibian, which respire primarily through their skin, thick-skinned species depend more on their lungs for respiration. Noble (1954:432) states "...the mechanism of keeping the skin moist is dependent on the environment, ...[and] restricts the habitat of these animals."

Plethodontid salamanders (lifeform 4, Appendix 13.2) require cool, damp microhabitats, although no permanent waterbody is necessary. Most prefer mesic rather than hygric sites[2]. The western redback salamander (Plethodon vehiculum) is an exception and is thought to be able to tolerate hygric sites (Stebbins 1954). In order to remain in their preferred microenvironment, plethodontid salamanders undergo seasonal vertical and horizontal migrations (Heatwole 1962). When the forest floor is wet, salamanders uses the litter layer. As drying occurs, they migrate into the deeper layers of the substrate. Surface depressions, abandoned burrows, and the underside and interior of logs ("chunky" logs are preferred) provide refuge during conditions producing physiological drought. Heatwole (1962) found that the critical level of soil moisture (i.e. interstitial relative humidity) for the plethodontid salamander, Plethodon cinereus, to be 85% (dry wt.). A humid micro-environment is also necessary for reproduction. The interior of rotting logs and underground cavities are usual sites. These components of the habitat (Appendix 13.3) are most prevalent in advanced stages of forest succession (Appendix 13.4).

Some amphibians, although spending the majority of their time in a terrestrial habitat, have retained their ancestral dependence on water for reproduction (lifeform 2). Humid sites characterize the terrestrial habitats required by these species (Appendix 13.2). All inhabit the riparian zone. western toad, Pacific treefrog, and red-legged frog are able to forage some

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[2] See A field guide for identification and interpretation of ecosystems. 1983. (B.C. Ministry of Forests) for definitions of these terms.

distance from water and suggests that some lifeform 2 species can tolerate drier conditions than other members of this lifeform. Like the plethodontid salamanders, all species in this lifeform require humid retreats.

The majority of Vancouver Island's aquatic breeding amphibians can reproduce in either temporary or permanent water bodies (Appendix 13.2). Their reproductive success is dependent, however, upon the length of time the larvae or tadpoles need to metamorphose. Only Northwestern salamander and roughskin newt require permanent water for reproduction. Size and flow rate of the water body or waterway used varies with the species (Appendix 13.3). While there appears to be no preferred water body size, fast flowing water is avoided by most species. Aquatic vegetation is required for the support of deposited egg masses of Northwestern salamander, long-toed salamander, roughskin newt, western toad, and Pacific tree frog (Appendix 13.2). Because fish species are potential predators of embryos and larvae, some species breed only in water devoid of "large" fish. The required habitat components for aquatic reproduction are not restricted by the stage of forest succession surrounding the water source (Appendix 13.4).

While moisture appears to be the most important abiotic factor influencing local distribution of amphibians, temperature may be responsible for influencing their micro-distribution. For example, Heatwole (1962) reports that although the moisture regime of an oak-pine-aspen forest was favourable, Plethodon cinereus was not found in their preferred habitat (i.e. the layer beneath conifer litter). He notes that the temperature under the conifer litter rose to 39° C, and this is above the CTM (critical thermal maxima) reported for all plethodontids. Thermal maxima and minima have been identified for many species that occur on Vancouver Island (Table 4). These values were, however, collected in latitudes south of British Columbia, and Brattstrom and Warren (1955) suggest that geographical variation in temperature tolerance and seasonal acclimation is probable. Brattstrom (1963), in his review of the thermal requirements of amphibians, reports studies which support this temperature observation. For example, a Pacific treefrog population in Oregon was found to operate a few degrees lower than one in southern California. It is therefore likely that temperature

TABLE 4. Voluntary thermal maxima and minima for some Vancouver Island amphibian species

Species	Min (°C)	Max (°C)	Mean (°C)
Indigenous			
Roughskin Newt	12.5	18.4	14.8
Western Redback Salamander	9.2	12.5	10.5
Oregon Ensatina	1.0	20.0	10.6
Clouded Salamander	16.0	20.5	17.5
Western Toad	3.0	29.5	21.3
Pacific Treefrog	3.8	24.0	16.2
Red-legged Frog	9.8	19.0	13.3
Introduced			
Bullfrog	11.5	30.0	14.0
Green Frog	10.0	29.0	24.5
Northern Leopard Frog	17.8	34.7	24.4

Compiled from Brattstrom (1963)

tolerances and activity temperatures for amphibians in British Columbia will be different than those presently reported.

Food availability does not appear to be a limiting factor. Wherever a habitat is suitable for amphibians, it will also be suitable for the soft-bodied invertebrates and insects on which they prey (Appendix 13.3).

8.2 Reptiles

Reptiles occur in a variety of habitats. Unlike amphibians, desiccation is not a major problem. Most depend on the sun for thermoregulation and are often seen basking. Some species are strictly terrestrial (lifeform 5, Appendix 13.2); others prefer habitats associated with water (lifeform 3, Appendix 13.2). One species, the painted turtle (C. picta), lives a major portion of its life in the water. All reptiles reproduce on land.

The painted turtle (C. picta) lives in permanent ponds or lakes that support aquatic vegetation and some debris; these provide food and basking sights (Appendix 13.2). In the spring (April/May), the painted turtle emerges from its aquatic habitat to lay its eggs. Eggs are deposited in areas where the substrate is suitable for digging (Campbell pers. comm.), usually within 46 m of the water's edge. South-facing slopes are preferred (Orchard pers. comm.). These sites are reported to have a higher probability of hatchling success because of the warmer nest environment they provide for developing turtles (Orchard pers. comm.). During their migration from aquatic to nesting sites, painted turtles are very susceptible to predation.

The western terrestrial garter snake (T. elegans) is rarely found far from water. Arid rocky, beach, or grassy habitat adjacent to marine or fresh water is preferred (Appendix 13.2 and 13.3). It is a generalized feeder and forages in both aquatic and terrestrial habitat. In times of stress, it may enter water to escape (Fitch 1940).

The common garter snake (Thamnophis sirtalis) is referred to as the swamp snake and prefers the damp or saturated areas within the thick vegetation adjacent to water. This species' habitat appears to be related to the availability of its major prey, amphibians and earthworms (Gregory 1978).

The northwestern garter snake (Thamnophis ordinoides) is strictly terrestrial and prefers the dense vegetational areas along openings (Appendix 13.2 and 13.3) found adjacent to the early stages of succession (Appendix 13.4). This habitat provides protection from predators and supports their major prey items, earthworms and slugs (Gregory 1978).

Very little is known about the sharptail snake (C. tenuis). It is found in forested areas near streams and its activity pattern has been observed to coincide with the rainy season. Its preference for a moist habitat characteristic of mature forest (Appendix 13.4) may be due to the fact that this habitat supports its principal (only?) prey species, slugs. Orchard (pers. comm.) is presently investigating the possibility that only one slug species is eaten.

The western skink (E. skiltonianus) prefers the damp habitat found under leaf litter and decaying logs, and behind the loose bark of loop and stumps. In this habitat its main prey, insects and spiders, are plentiful.

The northern alligator lizard (Gerrhonotus coerruleus) prefers dry, rocky areas adjacent to forests (Appendix 13.2 and 13.3). This habitat provides the prey -- spiders and insects -- the escape cover and hibernacula necessary for survival. Rocky fissures on west- or south-facing slopes are preferred. Disturbed areas, such as clearcuts, which have an abundance of debris and maximum sun exposure, can support thriving populations of alligator lizards.

As the preceding text indicates, specific habitat requirements or limiting factors are unknown for most species and hypothesized for others. Generally, it appears that if thermally stable, year-round retreats are available, the presence or absence of reptiles is dependent upon the habitat's ability to support the species' particular prey.

9 EFFECTS OF INTENSIVE FOREST MANAGEMENT

Information available on the effects of forest practices on amphibian and reptile species is limited. Only three papers are available, all on amphibian species: Blymyer and McGinnes 1977, Stelmock and Harestad 1979, Bennett et al. 1980. Only one paper documents herpetological research on Vancouver Island (Stelmock and Harestad 1979).

Because of the paucity of literature, information on species life history and on the abiotic factors that influence species distribution (Appendix 13.5) were used to analyse the effects of forest practices on amphibian and reptile species (Appendix 13.6). These tables are hypotheses and are presented to elicit criticism and discussion. The following text briefly describes the effects intensive forest management practices have on the environment and correlates these to impacts on a lifeform or species.

Only the effects of forest practices which appear to have some bearing on amphibian and reptile species are discussed. For example, the relationship between canopy cover and snow depth are not presented since all Vancouver Island's amphibian and reptile species hibernate, and therefore are inactive in winter.

9.1 Amphibians

9.1.1 Terrestrial habitat

Some individuals survive the logging site operations; however, since postlogging site preparation may involve slashburning or scarification all resident amphibian species are probably extirpated. Consequently, it is important to identify when a clearcut becomes favourable for re-colonization.

The literature suggests that moisture and temperature are the most important factors influencing local distributions of amphibians in the clearcut (Heatwole 1962, Blymyer and McGinnes 1977, Appendix 13.6). Stelmock and Harestad (1979) indicate that the micro-characteristics are more important than the macro-characteristics of forest succession. Microclimatic changes after clearcutting (Hallin 1967, Hooven 1973) and in forest succession (Geiger 1966) have been documented.

Blymyer and McGinnes (1977) suggest that clearcutting is detrimental to many terrestrial amphibian species for at least 8 years after logging. In this study, species use of the clearcut was restricted to the forest margin (two anuran species, lifeform 2). Stelmock and Harestad (1979) found no significant difference in clouded salamander (A. ferreus, lifeform 4) densities among 8 year-old, 28 year-old and old-growth forest stands. They attribute this to the micro-characteristic similarities of the three

successional stages, the patch-cutting regime used in the area, and the availability of a colonizing population from the regenerating and old-growth forest surrounding the clearcut. They conclude that forest harvesting has no long-term effect on this species. Bennett et al. (1980) suggest that the development of a variety of amphibian niches is achieved between 24 and 26 years after logging with the development of extensive undergrowth, ground litter, and decaying stumps and logs.

9.1.2 Aquatic habitat

Aquatic breeding amphibians (lifeform 2) are dependent upon the quantity and quality of water available. The increase in water yield following clearcutting is well documented (Chapman 1962, Hooven 1973, Bell et al. 1974, Harr 1976a and b, Johnson and Beschta 1980). Tractor and skidder logged areas are considered to be the greatest contributing causes (Chapman 1962, Johnson and Beschta 1980). As well as creating an increase in stream flow, flow peaks are higher and occur earlier in the season. This alteration to flow of water, especially at a time when breeding is commencing, creates an unsuitable aquatic environment. As a consequence, species that require slow-moving waterways are unable to uses a previously available site. Rapid changes in the water level of standing water bodies may also affect the species breeding there. Species that attach their eggs to aquatic vegetation are likely more adversely affected than those that deposit free-floating egg masses.

The quality of water is affected by alterations in sedimentation, temperature, and chemical composition. Clearcutting and logging operations, such as road building, tractor and skidder usage, cause an increase in sedimentation (Chapman 1962). Sedimentation, in turn, effectively reduces aquatic vegetation, insect populations, and dissolved oxygen concentration. Accordingly, amphibian species, which require aquatic vegetation to support their deposited egg mass and for cover, will be adversely affected (lifeform 2). A reduction in the availability of aquatic insects, an important diet item, will affect both larvae and adults. In addition, a decrease in the concentration of dissolved oxygen is known to cause death to early aquatic stages (i.e. egg and larvae).

Removal of the riparian vegetation during logging results in higher summer stream temperatures and lower winter temperatures (Chapman 1962, Hooven 1973). Higher water temperatures increase the metabolic rate of developing larvae, and this results in an increase in growth rate (lifeform 2). Metamorphosis will occur sooner. However, warmer waters also increase the susceptibility of aquatic embryos to disease (e.g. fungal infection) and decrease the concentration of dissolved oxygen. Critical thermal limits have not been defined for amphibian larvae (Orchard pers. comm.). Larvae that overwinter in water (i.e. northwestern salamander [A. gracile] and roughskin newt [T. granulosa]) may be adversely affected by the colder winter stream temperatures.

Herbicides, pesticides and soil nutrient leaching alter the chemical composition of available water (Chapman 1962, Brown 1978:323). The effects many of the chemicals have on aquatic vertebrate species, particularly amphibians, are not well documented.

Of the herbicides presently used on Vancouver Island (Ellis 1980), only one has been tested for its toxicity to amphibians. The herbicide 2,4-D inhibited the development of Rana temporaria eggs at 5000 ppm, and at 500 ppm it caused malformations of the tail of the developing tadpoles (Brown 1978:414). Literature documenting the lethal concentration values (LC_{50}) for the amphibian species which inhabit Vancouver Island is unavailable.

Pesticides for insect control have not been used on Vancouver Island since 1973, except in nurseries (Finnis pers. comm.). In 1973, fenitrothion was aerial sprayed to control western black budworm in the Port Alice area (Lejeune 1975). Fenitrothion has been observed to have no direct effect on salamander larvae (Pearce and Price 1975). Prior to 1973, in the 1950's and 1960's, DDT was widely used. The detrimental effects of this pesticide on the environment are well documented (Brown 1978) and, consequently it is no longer in use. In fresh water, the presence of herbicides and pesticides often brings about changes in nutrient concentration decreasing aquatic invertebrate population densities and removing aquatic vegetation (Chapman 1962, Brown 1978). These effects, are thus harmful to inhabiting amphibian

species. Because of the mobility and pervasiveness of chemicals, their potential long-term environmental effects are unknown.

9.2 Reptiles

The abiotic parameters of the surface microhabitat do not appear to dramatically influence the local distribution of reptiles. Rather, it appears that it is the abiotic parameters affecting thermoregulation (i.e. seasonal ambient temperature range, sun exposure) that influences their distribution (Gregory pers. comm.). If basking sites, thermally stable retreats, and hibernacula are available, the presence of reptiles depends upon the ability of the habitat to support their prey.

Undoubtedly, the majority of individuals will be extirpated from a clearcut following site preparation. However, since logging reverts forest succession to its earliest stage (i.e. grass/forb), species that are able to utilize a xeric environment will not be restricted; some will likely benefit. For example, Gerrhonotus spp. and Thamnophis spp. (lifeform 5) have been observed on slashburned clearcuts after compaction of the ash layer by rain (Hooven 1973). Lais (1976) reports that the northern alligator lizard (G. coerruleus) "...thrives in disturbed areas, ...clearcuts, where there is an abundance of debris." The northwestern garter snake (T. ordinoides), rarely found in dense forest, inhabits the area of thick vegetation along openings and therefore will likely benefit from logging providing prey densities are increased or unaffected.

Logging practices that destroy or decrease the availability of a humid or moist habitat may restrict the distribution of the western skink (E. skiltonianus) and the sharptail snake (C. tenuis) (lifeform 3). If the distributions of these species are as limited as presently is believed, intensive forest management in the known populated areas would extirpate both species.

The common garter snake (T. sirtalis) and the western terrestrial garter snake (T. elegans) (lifeform 3) inhabit, respectively, the hygric and xeric

regimes adjacent to fresh and marine waters. Logging practices will probably not have a direct effect on these species. The painted turtle (C. picta) (lifeform 3), while it inhabits the aquatic environment for the majority of its life, it nests on land and therefore must leave the water to deposit its eggs. As a result, during the nesting season, female painted turtles are threatened by the presence of logging roads that cross the migration routes to the nest sites (Orchard 1980). Since water is a major component of this species' habitat, any change to the quality and quantity of water will have an effect on the turtles, similar to that experienced by aquatic amphibians. (The effects of logging on an aquatic environment were discussed in Section 8.1.) For reptiles, food availability is the requirement probably most affected.

10 DISCUSSION AND RECOMMENDATIONS

As indicated in Section 8, the information presented here and in Appendices 13.5 and 13.6 is hypothetical. The hypotheses are based on general amphibian and reptile physiology, species habitat preferences, and the effects of forest practices on the environment. Given the lack of specific information, this approach was used to identify why species prefer certain habitats and so enable the prediction of how intensive forest management practices will affect amphibians and reptiles.

The information in Appendices 13.5, 13.6, and 13.7 can be used to establish priority needs and determine the research questions requiring investigation. As this research data becomes available, it can be incorporated with current detailed information on certain species to develop a clearer understanding of species physiology and the microclimatic regime of (a) forest succession, (b) biogeoclimatic zones (subzones), and (c) forest practices; and thus, enable clarification of the interrelationship between species physiology, habitat preferences and available environmental regimes. A species research priority list is presented in Appendix 13.7 .

This analysis identified Oregon ensatina and sharptail snake as the high priority amphibian and reptile species, respectively. Research questions in need of investigation are listed below, in order of priority.

Oregon ensatina

Determine the relative humidity and critical thermal maximum (CTM) limits for Oregon ensatina.

Is the distribution of Oregon ensatina restricted to the Coastal Douglas-fir Biogeoclimatic Zone?

Sharptail snake

Is the distribution of the single prey species, Prophysoan spp., the ultimate factor limiting the distribution of the sharptail snake?

Is the distribution of the sharptail snake restricted to the Coastal Douglas-fir Biogeoclimatic Zone?

Displacement of native frogs by introduced species

Does clearcutting facilitate the dispersal of introduced bull and leopard frogs and displacement of native red-legged frog populations?

Water temperature fluctuations

What are the critical thermal minimum temperatures for overwintering 1) Northwestern salamander and 2) rough-skin newt?

Water quantity fluctuations

What are the maximum water velocity limits for survival of amphibian aquatic eggs and larvae?

11 SUMMARY

Emphasized in this analysis is the paucity of pertinent information concerning distributions, habitat, and natural history of amphibians and reptiles. Very little research has been done on Vancouver Island or elsewhere in B.C. and therefore the majority of available information comes from more southern latitudes outside the province.

The current distribution of Vancouver Island species is presented, although records are few. Habitat utilization and life histories are presented and form the basis for species habitat requirements. The

information suggests that moisture and temperature are the major factors influencing amphibian habitat selection. A common factor influencing reptilian habitat selection is not as apparent although food availability is suggested as the critical limiting factor. Adequate cover, thermally stable retreats, and hibernacula are habitat requirements for both amphibians and reptiles.

Documentation on the effects of intensive forest management on amphibians and reptiles is limited. As a result, hypotheses were formulated and provide the basis for the assessment of the impact of forest practices on these animals. The analysis identified Oregon ensatina and the sharptail snake as the high priority species. Research questions that address the distribution of these species and the factors limiting their distribution, as well as the displacement of native species by introduced amphibians and the critical abiotic parameters are presented.

12 REFERENCES

Behler, J.L. and F.W. King. 1979. The Audubon Society field guide to North American reptiles and amphibians. Alfred A. Knopf, Inc., New York. 719 p.

Bell, M.A.M., J.M. Beckett and W.F. Hubbard. 1974. Impact of harvesting on forest environments and resources. Pacific Forest Research Centre, Canadian Forestry Service, Environment Canada, Victoria, B.C. 141 p.

Bennett, S.J., J. Whitfield Gibbons and J. Glanville. 1980. Terrestrial activity abundance and diversity in differently managed forest types. American Midland Naturalist 103(2):412-416.

Blymyer, M.J. and B.S. McGinnes. 1977. Observations on possible detrimental effects of clearcutting on terrestrial amphibians. Bulletin of the Maryland Herpetological Society 13(2):79-83.

Brattstrom, B.H. 1963. A preliminary review of the thermal requirements of amphibians. Ecology 44(2):238-255.

_____ and J.W. Warren. 1955. Observations on the ecology and behaviour of the Pacific treefrog, Hyla regilla. Copeia 1955:181-191.

B.C. Ministry of Environment. 1979. Preliminary reptile management plan for British Columbia. Fish and Wildlife Branch, Victoria, B.C. 24 p.

_____. 1980. Preliminary amphibian management Plan for British Columbia. Fish and Wildlife Branch, Victoria, B.C. 29 p.

B.C. Ministry of Forests. 1983. A field guide for identification and interpretation of ecosystems. Research Branch, Victoria, B.C.

Brown, A.W.A. (ed.). 1978. Ecology of pesticides. John Wiley & Sons, Toronto, Ontario. 525 p.

Campbell, R. W. 1969. Notes on some food of the wandering garter snake on Mitlenatch Island, British Columbia. Syesis 2(1/2):183-187.

Cannings, R. and K. Kennedy. 1965. A study of the garter snakes on Miracle Beach. British Columbia Parks Branch, Victoria, B.C. Unpublished report.

Carl, G.C. 1966a. The amphibians of British Columbia. British Columbia Provincial Museum Handbook No. 2. Victoria, B.C. 63 p.

_____ 1966b. The reptiles of British Columbia. British Columbia Provincial Museum Handbook No. 3. Victoria, B.C. 65 p.

_____ and C.J. Guiguet. 1956. Notes on the flora and fauna of Busby Islands, British Columbia. Report of the Provincial Museum Natural History and Anthropology for the Year 1955, Victoria, B.C. p. 31-44.

Chapman, D.W. 1962. Effects of logging upon fish resources of the west coast. Journal of Forestry 60(6):553-537.

Dawe, N.K. 1976. Some notes on the comparative ecology of garter snakes of the genus Thamnophis at Qualicum Beach, British Columbia. Canadian Wildlife Service, Qualicum Beach, B.C. Unpublished Report. 17 p.

Dumas, P.C. 1964. Species-pair allopatry in the genera Rana and Phynosoma. Ecology 45(1):178-181.

Ellis, R.M. 1980. Problem analysis: intensive silviculture-wildlife interactions: research needs on Vancouver Island. Research Branch, British Columbia Ministry of Forests, Victoria, B.C. Unpublished report. 63 p.

Ferguson, D.E. 1963. Ambystoma macrodactylum. In Catalogue of American amphibians and reptiles. W.J. Riemer (ed.) American Society of Ichthyologists and Herpetologists, Bethesada, Maryland. p. 4.

Fisheries Act. 1979. Revised Statutes of British Columbia 1979. Chapter 137.

Fitch, H.S. 1940. A biogeographical study of the ordinoides artenkreis of garter snakes (Genus Thamnophis). Univeristy of California, Berkley, Cali. Publications in Zoology 44(1):1-150.

Geiger, R. 1966. Climate near the ground. Harvard University Press, Cambridge, Massachusetts. 611 p.

Green, D.M. 1978. Northern leopard frogs and bullfrogs on Vancouver Island. Canadian Field-Naturalist 92(1):78-79.

_____ and R.W. Campbell. 1980. The Amphibians of British Columbia. Unpublished report, Vertebrate Zoology Division, British Columbia Provincial Museum. 105 pp.

Gregory, P.T. 1978. Feeding habits and diet overlap of three species of garter snakes (Thamnophis) on Vancouver Island. Canadian Journal of Zoology 56(9):1967-1974.

_____ and R.W. Campbell. 1980. The reptiles of British Columbia. Vertebrate Zoology Division, British Columbia Provincial Museum, Victoria, B.C. Unpublished report. 101 p.

_____ and A.G.D. McIntosh. 1980. Thermal niche overlap in garter snakes (Thamnophis) on Vancouver Island. Canadian Journal of Zoology 58(3):351-355.

_____, J.M. McCartney and D.H. Rivard. 1980. Small mammal predation and prey handling behaviour by the garter snake Thamnophis elegans. Herpetologica 36(1):87-93.

_____ and M.G. Shepard. 1980. Reptiles of British Columbia. British Columbia Provincial Museum Handbook Series. Unpublished draft.

Hallin, W.E. 1967. Soil-moisture and temperature trends in cutover and adjacent old-growth Douglas-fir timber. USDA Forest and Range Experiment Station Research Note PNW-56. 11 p.

Harr, R.D. 1976a. Forest practices and streamflow in western Oregon. USDA Forest Service General Technical Report PNW-49. 18 p.

_____. 1976b. Hydrology of small forest streams in western Oregon. USDA Forest Service General Technical Report PNW-55. 14 p.

Heatwole, H. 1962. Environmental factors influencing local distribution and activity of the salamander, Plethodon cinereus. Ecology 43(3):460-472.

Hooven, E.F. 1973. A wildlife brief for the clearcut-logging of Douglas-fir. Journal of Forestry. (4):220-214.

Jaremovic, R.V. 1978. Distribution and movements of the Salamander Aneides ferreus (Cope, 1869) on Cleland Island, British Columbia. B.Sc. thesis. University of British Columbia, Vancouver, B.C. 47 p.

Johnson, M.G. and R.L. Beschta. 1980. Logging, infiltration capacity, and surface erodibility in western Oregon. Journal of Forestry 78(6):334-337.

Klinka, K., F.C. Nuszdorfer and L. Skoda. 1979. Biogeoclimatic units of central and southern Vancouver Island. British Columbia Ministry of Forests, Victoria, B.C. 120 p.

Lais, P.M. 1976. Gerrhonotus coeruleus. In Catalogue of American amphibians and reptiles. Society for the Study of Amphibians and Reptiles. p. 178.1-178.4.

Lejeune, R.R. 1975. Western black-headed budworm. In Aerial control of forest insects in Canada. M.L. Prebble (ed.) Department of Environment, Ottawa, Ontario. 141 p.

Licht, L.E. 1971. The ecology of coexistence in two closely related species of frogs (Rana). Ph.D. thesis. University of British Columbia, Vancouver, B.C. 27 p.

MacIntyre, D.H. and R.V. Palermo. 1980. The current status of the Amphibia in British Columbia. In Proceedings, symposium on threatened and endangered species and habitats in British Columbia and the Yukon. R. Stace-Smith, L. Johns and P. Joslin (ed.) Fish and Wildlife Branch, British Columbia Ministry of Environment, Victoria, B.C. 302 pp.

Moyle, P.B. 1973. Effects of introduced bullfrogs, Rana catesbeiana on the native frogs of the San Juaquin Valley, California. Copeia 1973(1):18-22.

Niemi, G.J. and L. Pfanmuller. 1979. Avian communities: approaches to describing their habitat association. In Management of north central and the northeastern forests for nongame birds. USDA Forest Service General Technical Report NC-51. 268 p.

Noble, G.K. 1954. The biology of the Amphibia. Dover Publications, Inc. New York, New York. 577 p.

Orchard, S.A. 1978a. Amphibians of British Columbia. British Columbia Fish & Wildlife Branch, Victoria, B.C. Unpublished report. 92 p.

_____. 1978b. Reptiles of British Columbia. British Columbia Fish & Wildlife Branch, Victoria, B.C. Unpublished report. 72 p.

_____. 1980. The status of reptiles in British Columbia. In Proceedings, symposium on threatened and endangered species and habitats in British Columbia and Yukon. Stace-Smith, R., L. Johns and P. Joslin (ed.). Fish and Wildlife Branch, British Columbia Ministry of Environment, Victoria, B.C. 302 p.

_____. 1981. The sharptail snake, Contia tenuis, on Vancouver Island. Unpublished report. 3 p.

Packee, E. 1975. Subzone map of Vancouver Island. MacMillan Bloedel Ltd., Forestry Division.

Pearce, P.A. and I.M. Price. 1975. Effects on amphibians. In Aerial control of forest insects in Canada. M.L. Prebble (ed.) Department of Environment, Ottawa, Ontario. 141 p.

Schaub, D.L. and J.H. Larsen, Jr. 1978. The reproductive ecology of the Pacific treefrog (Hyla regilla). Herpetologica. 34(4):409-416.

Stace-Smith, R., L. Johns and P. Joslin (ed.). 1980. Proceeding, symposium on threatened and endangered species and habitats in British Columbia and the Yukon. Fish and Wildlife Branch, British Columbia Ministry of Environment, Victoria, B.C. 301 p.

Stebbins, R.C. 1954. Amphibians and reptiles of western North America. McGraw-Hill, New York. 536 p.

Stelmock, J.J. 1976. Life history and feeding strategies of Aneides ferreus (Cope, 1869) (Urodela: Plethodontidal). B.Sc. thesis, Department of Zoology, University of British Columbia, Vancouver, B.C. 66 p.

_____ and A.S. Harestad. 1979. Food habits and life history of the clouded salamander (Aneides ferreus) on northern Vancouver Island, British Columbia. Syesis 12:71-75.

Stirling, D. 1962. Reptiles and amphibians of Miracle Beach. British Columbia Parks Branch, Victoria, B.C. Unpublished report. 2 p.

Synder, R.C. 1962. Ambystoma gracile. In Catalogue of American amphibians and reptiles. W.J. Reimer (ed.) American society of Icthyologists and Herpetologists, Bethesda, Maryland. p. 6.

Thomas, J.W. (ed.). 1979. Wildlife habitats in managed forests: the Blue Mountains of Oregon and Washington. USDA Forest Service Agriculture Handbook No. 553. 512 p.

Tracy, R. 1975. Water and energy relations of terrestrial amphibians: Insights from mechanistic modeling: In Perspectives of biophysical ecology. D.M. Gates and R.B. Schmerl (ed.). Springer-Verlag, New York. 609 p.

Vitt, L.J. 1968. Reproductive Biology of the Anquid Lizard, Gerrhonotus coeruleus principis. M.Sc. thesis. Western Washington University, Bellingham, Wash. 62 p.

_____. 1969. The northern alligator lizard, Gerrhonotus coeruleus principis from west of the Cascade Mountain range. Bulletin of the Pacific Northwest Herpetological Society. 4(2):6-7.

Wake, D.B. 1965. Aneides ferreus. In Catalogue of American amphibians and reptiles. American Society of Ichthyologists and Herpetologists. Bethesda, Maryland. p. 16.1-16.2.

Watney, G.S. 1941. Notes on the life history of Ambystoma gracile BAIRD. Copeia 1941(1):14-17.

Wildlife Act. 1982. Statutes of British Colubmia. Chapter 57.

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APPENDIX 13.1 Amphibians and reptiles on Vancouver Island

Indigenous Species

Common Name	Scientific Name
AMPHIBIANS	
Northwestern Salamander	*Ambystoma gracile*
Long-toed Salamander	*Ambystoma macrodactylum*
Roughskin Newt	*Taricha granulosa*
Western Redback Salamander	*Plethodon vehiculum*
Oregon Ensatina	*Ensatina eschscholtzi*
Clouded Salamander	*Aneides ferreus*
Western Toad	*Bufo boreas*
Pacific Treefrog	*Hyla regilla*
Red-legged Frog	*Rana aurora*
REPTILES	
Painted Turtle	*Chrysemys picta*
Northern Alligator Lizard	*Gerrhonotus coeruleus*
Sharptail Snake	*Contia tenuis*
Common Garter Snake	*Thamnophis sirtalis*
Western Terrestrial Garter Snake	*Thamnophis elegans*
Northwestern Garter Snake	*Thamnophis ordinoides*
?Western Skink	*Eumeces skiltonianus*

Introduced Species

AMPHIBIANS	
Green Frog	*Rana clamitans*
Northern Leopard Frog	*Rana pipiens*
Bullfrog	*Rana catesbeiana*

? indigenous status on Vancouver Island currently questioned

APPENDIX 13.2: Species life history by lifeform

The information presented in the following tables was compiled from the following sources:

Behler, J.L. and F.W. King 1979.
B.C. Ministry of Environment 1979, 1980.
Campbell, R. W. 1969.
Cannings, R. and K. Kennedy 1965.
Carl, G.C. 1966a and 1966b.
Carl, G.C. and C.J. Guiguet 1956.
Dawe, N.K. 1976.
Dawe, N.K. (personal communication).
Ferguson, D.E. 1963.
Green, D.M. and R.W. Campbell 1980.
Gregory, P.T. 1978.
Gregory, P.T. and R.W. Campbell 1980.
Gregory, P.T. and A.G.D. McIntosh 1980.
Gregory, P.T., J.M. McCartney and D.H. Rivard 1980.
Gregory, P.T. and M.G. Shepard 1980.
Jaremovic, R.V. 1978.
MacIntyre, D.H. and R.V. Palermo 1980.
Orchard, S.A. 1978a and 1978b.
Schaub, D.L. and J.H. Larsen, Jr. 1978.
Stebbins, R.C. 1954.
Stelmock, J.J. 1976.
Stelmock, J.J. and A.S. Harestad 1979.
Stirling, D. 1962.
Synder, R.C. 1962.
Wake, D.B. 1965.
Vitt, L.J. 1968, 1969.
Watney, G.S. 1941.

Complete citations are included in Section 12.

APPENDIX 13.2 Species life history by lifeform (continued)

LIFEFORM DESCRIPTIONS

Lifeform 1[1]: Reproduces in water. Feeds in water.

Bullfrog (Rana catesbeiana) introduced to Vancouver Island

Lifeform 2: Reproduces in water. Feeds on ground, in bushes and/or in trees.

Northwestern Salamander (Ambystoma gracile)
Long-toed Salamander (Ambystoma macrodactylum)
Roughskin Newt (Taricha granulosa)
Western Toad (Bufo boreas)
Pacific Treefrog (Hyla regilla)
Red-legged Frog (Rana aurora)
Green Frog (Rana clamitans) introduced to Vancouver Island
Northern Leopard Frog (Rana pipiens) introduced to Vancouver Island

Lifeform 3: Reproduces on ground around water. Feeds on ground and in water.

Painted Turtle (Chrysemys picta)
Sharptail Snake (Contia tenuis)
Common Garter Snake (Thamnophis sirtalis)
Western Terrestrial Garter Snake (Thamnophis elegans)

Lifeform 4: Reproduces on ground in moist environment. Feeds on ground.

Oregon Ensatina (Ensatina eschscholtzi)
Clouded Salamander (Aneides ferreus)
Western Redback Salamander (Plethodon vehiculum)

Lifeform 5: Reproduces on ground without specific water. Feeds on ground.

Northern Alligator Lizard (Gerrhonotus coerruleus)
Northwestern Garter Snake (Thamnophis ordinoides)
Western Skink (Eumeces skiltonianus) (introduced?)

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[1]A life history table for lifeform 1 has not been included in this analysis. The bullfrog is an introduced species and discussion is limited to indigineous species.

APPENDIX 13.2 Species life history by lifeform (continued)

Lifeform 2: Reproduces in water. Feeds on ground, in bushes, and/or in trees.

SPECIES	HABITAT	FOOD	REPRODUCTION	EGG MASS/DEPOSITION	SHELTER &/OR SECURITY	COMMENTS
Northwestern Salamander *Ambystoma gracile*	humid sites; prefer forest margins and pond banks under litter and rotting logs in deciduous and coniferous forests	slugs & other soft bodied insects	migrate to permanent ponds with moderate amount of vegetation near woodlots or forestes; must be devoid of 'large' fish	large egg masses formed around submerged vegetation; green tinge due to algae present; deposited between Feb and May	under forest litter and rotting wood	bound to permanent bodies of water; larvae require one year to metamorphsis
Long-toed Salamander *Ambystroma macrodactylum*	damp areas at forest margins; under rotting logs generally not far from standing water	small invertebrates and insects	shallow temporary or permanent ponds with ample vegetation	small clumps attached to submerged vegetation or on bottom; deposited shortly after snow melts and ponds become ice free	spend large amounts of time underground in abandoned burrows, natural hollows, or crevices	
Western Toad *Bufo boreas*	damp areas; forests, fields, meadows, about standing water and waterways	worms, slugs, and insects; primarily nocturnal forager	mature ponds and lakes with accumulated bottom detritus; some vegetation, sedge-reed, at water's edge	long strings entwined among submerged vegetation; mating March to May	nocturnal; retires to damp hole or shaded spot at dawn; among surface debris or rocks, in rodent burrows	
Pacific Treefrog *Hyla regilla*	on ground, or in shrubbery in riparian or moist upland habitat	variety of flying and crawling insects	shallow weedy temporary or permanent ponds or swamps	small loose clusters about submerged vegetations; spawns May to July	seek shelter in rock fissures, vegetation along streams, rodent burrows, nooks and crannies, culverts	
Red-legged Frog *Rana aurora*	forest-dwelling frog; in vegetation along ponds, swamps, streams, lakes, in or adjacent to sheltering forests	insects and other forest invertebrates	backwaters of lakes and streams;	loose, round masses attached or free-floating; deposited during April and May	will escape to water (especially when small) but usually relys on ground vegetation	populations of this species are threatened by two introduced species—bullfrog & greenfrog
Roughskin Newt *Taricha granulosa*	humid coastal or mixed forests close to permanent ponds or swamps; prefer open woods with accumulation of deadfall litter	soft bellied invertebrates such as slugs and worms	slow-moving streams; standing water, bogs or swamps	attached singly or in small clumps to aquatic plants; deposited early spring to July		

APPENDIX 13.2 Species life history by lifeform (continued)

Lifeform 3: Reproduces on ground around wter. Feeds on ground and in water.

SPECIES	HABITAT	FOOD	REPRODUCTION	EGG MASS/DEPOSITION	SHELTER &/OR SECURITY	COMMENTS
Painted Turtle *Chrysemys picta*	highly aquatic; bodies of fresh water of every conceivable type except fast-flowing water; prefer shallow water bodies with thick vegetation and sloping shores	omnivorous; feeds primarily on invertabrates as well as frogs, fish, and vegetation	prefer sandy soil on south-facing slope for breeding site; usually within 43 meters from water	deposit 3-16 eggs between May and July; hatchlings may overwinter in nest	find refuge in thick aquatic vegetation; hibernate in bottom debris and mud of ponds	breeding females migrate from aquatic habitat to terrestrial nesting sites; some migrate between summer ponds and wintering ponds
Common Garter Snake *Thamnophis sirtalis*	swamp or marsh snake; damp areas within thick vegetation adjacent to water; estuaries, marshes, ditches, sedge meadows	mainly amphibians and earthworms; also intertidal and fresh water fish		bear live young, 2 to 85, in mid to late summer	communal denning or overwintering in northern part of its range	selection of habitat appears to be related to major prey, amphibians and earthworms
Western Terrestrial Garter Snake *Thamnophis elegans*	semi-aquatic snake rarely far from water; beach near driftwood along water's edge; grassy meadows, rocky hills	generalized feeder; slugs, fish, worms, small mammals, tidepool or fresh water fish		bear 8 to 17 young (viviparous) between August and September	frequent rocky intertidal and water to secure food and hide from enemies	
Sharptail Snake *Contia tenuis*	partial to moist environments; woodlands and forests especially near streams; found under debris	thought to be restricted to slugs	clutches found in cracks in rock outcropings with little soil, 6-12 inches below surface	2-9 eggs thought to be laid in summer and hatch in fall		very little known about its life history; most important single factor limiting distribution thought to be food preference-i.e. slugs

APPENDIX 13.2 Species life history by lifeform (continued)

Lifeform 4: Reproduces on ground in moist environment. Feeds on ground.

SPECIES	HABITAT	FOOD	REPRODUCTION	EGG MASS/DEPOSITION	SHELTER &/OR SECURITY	COMMENTS
Clouded Salamander *Aneides ferreus*	damp places under debris, stones, under bark of dead trees, damp moss; quite arboreal; found some distance above ground in tree cavities	ants and ground-dwelling arthropods	hollows or cavities in rotting logs, under bark; seem to prefer rotting Douglas-fir logs	10-20 unpigmented eggs attached to roof of cavity singly; female attends eggs; deposited late spring, early summer	spend dry season within logs; in clearings or open forest, hide under bark of trees, talus piles or moist rock piles	in B.C., found only on Vancouver Island
Oregon Ensatina *Ensatina eschscholtzi*	damp woods, Douglas-fir - vine maple forests, under debris, accumulated leaf litter, logs in advanced stages of decay	small arthropods and insects	usually underground in abandoned burrows; also under bark, forest litter in cavities of rotting logs	5-16 eggs deposited in damp habitat; female attends eggs; mating occurs in spring	much time spent in abandoned burrows, under bark, in rotting logs	most active after rains until surface aridity sends them underground; avoid saturated soils
Redback Salamander *Plethodon vehiculum*	damp, shaded woods beneath accumulated leaf litter and forest debris of Douglas-fir stands; dense undergrowth	primarily termites and soft-bodied invertabrates	moist location; cavity of log, hollow underground, among damp rocks	9-10 unpigmented eggs in grape-like clusters, attached to cavity wall; female attends eggs; deposited April to May		

APPENDIX 13.2 Species life history by lifeform (concluded)

Lifeform 5: Reproduces on ground without specific water. Feeds on ground.

SPECIES	HABITAT	FOOD	REPRODUCTION	EGG MASS/DEPOSITION	SHELTER &/OR SECURITY	COMMENTS
Northern Alligator Lizard *Gerrhonotus coeruleus*	dry rocky areas; exposed bluffs, rock slides; adjacent to woods or area of dense ground cover	insects and spiders	under rocks on south-facing slopes	4-7 young born in May and June; mating occurs in April	escape to cracks in large rocks and rock slides; hibernates in rock crevices; areas of dense ground cover	prefer cooler temperatures than most lizards; main host of tick *Ixodes pacificus*
Northwestern Garter Snake *Thamnophis ordinoides*	dense vegetation areas along openings; fields, roads, beaches, estuaries; not usually found in dense forest	earthworms and slugs		3-15 embryos found in gavid females; mate March-April, young born mid-summer	flee to safety of underbrush; hibernate underground from October to March	most active on sunny days
Western Skink *Eumeces skiltonianus*	damp places under decaying logs, under bark, rocks, leaf litter; woodlands, forests, grasslands with considerable herbaceous cover	insects and spiders	under some form of shelter, usually in tusk-shaped excavation under rock-imbedded in soil	soft, flexible blackish-brown eggs layed, 3-4 in number; female guards eggs; mate May-June		

APPENDIX 13.3 Species vs habitat component

The format used follows that presented by Thomas (1979). Information presented in Thomas' tables, from the literature, and from consultation with Harestad (pers. comm.) and Orchard (pers. comm.) were used.

									HABITAT COMPONENTS															
									- MARSH -							- EDGES -								
AMPHIBIANS	LIFEFORM	RIVERS	STREAMS	LAKES	SLOUGHS	RESERVOIRS	PONDS	INTERMIT PONDS	RUSH/CATTAIL	SEDGE	DECID VEG	STANDING WATER	RUNNING WATER	BEACHES	ESTUARIES	GRASS/SHRUB	SHRUB/FOREST	GRASS/FOREST	SNAGS	LOGS	BURROWS	CLIFF/ROCK	TALUS	CAVES
Northwestern Salamander	2		x	x			x					x	x				F	F		F	F			
Long-Toed Salamander	2			x	x	x	x	x	x	x	x	x				F	F	F			F		F	
Roughskin Newt	2		x	x	x		x		x	F	F	x	x			F	F	F		F	F		F	
Western Toad	2	x	x	x	x	x	x	x	x	x	x	R	R			F	F	F		F	F		F	
Pacific Treefrog	2	x	x	x	x	x	x	x	x	x	x	x	x			F	F	F	F	F		F	F	
Red-legged Frog	2		x	x	x	x	x	x	x	x	x	x	x			F	F	F						
Oregon Ensatina	4																x			x	x			
Western Redback Salamander	4															x	x	x		x	x			
Clouded Salamander	4																x	x	x	x	x			

R - reproduction only
F - feeding only
x - reproduction and feeding

APPENDIX 13.3 Species vs habitat component (continued)

	HABITAT COMPONENTS																							
	LIFEFORM	RIVERS	STREAMS	LAKES	SLOUGHS	RESERVOIRS	PONDS	INTERMIT POND S	RUSH/CATTAIL	SEDGE	DECID VEG	STANDING WATER	RUNNING WATER	BEACHES	ESTUARIES	GRASS/SHRUB	SHRUB/FORES T	GRASS/FORES T	SNAGS	LOGS	BUR ROWS	CLIFF/RIMROCK	TALUS	CAVES
									- MARSH -							- EDGES -								
REPTILES																								
Painted Turtle	3	x		x	x	x	x					x	x	R										
Common Garter Snake	3	F	F	F	F	F	F	F	F	F	F	F	F	x	x	x	x	x						
Western Terrestrial Garter Snake	3	F	F	F	F	F	F	F	F	F	F	F	F	x	x	x	x	x		x			x	
Sharptail Snake	3															x				x	x			
Western Skink	5															x	x	x		x	x	F	x	
Northwestern Garter Snake	5													x	x	x	x	x		x	x		x	
Northern Alligator Lizard	5													x			x	x		x		x	x	x

R - reproduction only
F - feeding only
x - reproduction and feeding

APPENDIX 13.4 Species vs successional stage

The format used follows that presented by Thomas (1979). Information presented in Thomas' tables, from the literature, and from consultations with Harestad (pers. comm.) and Orchard (pers. comm.) were used.

AMPHIBIANS	Grass Forb	Shrub Seedling 0 - 10 yr	Pole Sapling 11 - 39 yr	Young 40 - 79 yr	Mature 80 - 159 yr	Old Growth 160 + yr
Lifeform 2						
Northwestern Salamander	x			x	x	x
Long-toed Salamander	x	x	x	x	x	x
Roughskin Newt						x
Western Toad	x	x	x	x	x	x
Pacific Treefrog	x	x	x	x	x	x
Red-legged Frog	x	x	x	x	x	x
Lifeform 4						
Oregon Ensatina				x	x	x
Western Redback Salamander				x	x	x
Clouded Salamander		x	x	x	x	x

x - reproduces and feeds in this successional stage

APPENDIX 13.4 Species vs successional stage (continued)

AMPHIBIANS	Grass Forb	Shrub Seedling 0 - 10 yr	Pole Sapling 11 - 39 yr	Young 40 - 79 yr	Mature 80 - 159 yr	Old Growth 160 + yr
Lifeform 3						
Painted Turtle	x	x	x	x	x	
Common Garter Snake	x	x	x	x	x	x
Western Terrestrial Garter Snake	x	x	x	x	x	x
Western Skink	x	x	x	x	x	
Lifeform 5						
Sharptail Snake			x	x	x	
Northwestern Garter Snake	x	x				
Northern Alligator Lizard	x		x	x		

x - reproduces and feeds in this successional stage

APPENDIX 13.5 Effects of intensive forest management practices on abiotic parameters

FOREST PRACTICE	ABIOTIC PARMETERS: SURFACE Temperature[1]	SURFACE Humidity	SURFACE Debris	WATERSHED H_2O Quality	WATERSHED H_2O Available
Logging	+ range	-	+	-	+
Burning	+ range	-	-	-	-
Scarification	+ range	-	-	-	-
Planting	0	0	0	0	0
Cleaning[2]					
Chemical[3]	+ range	-	+	-	-
Mechanical	+ range	0	+	0	0
Spacing	+ range	0	+	0	0
Fertilization					
Immediate	0	0	0	-	0
Long term	-	+	0	0	-
Thinning	+ range	-	0	0	0
Chemical insect control	0	0	0	-	-

\+ Appreciable increase.
\- Appreciable decrease.
0 No appreciable effect.

[1] + range, denotes that the temperature range at the soil surface increases.
[2] Brush and weed control.
[3] Herbicides.

Information presented is the combined result of cited literature and consultations with Harestad (pers. comm.) and Orchard (pers. comm.).

APPENDIX 13.6 Effects of intensive forest management practices on amphibian and reptile species

SPECIES	LIFEFORM	LOGGING	BURNING	SCARIFICATION	CHEMICAL CLEANING	MANUAL CLEANING	SPACING	FERTILIZATION	THINNING
AMPHIBIANS									
Northwestern Salamander	2	-	-	-	-	0	+	0	0
Long-toed Salamander	2	-	-	-	-	0	+	0	0
Roughskin Newt	2	-	-	-	-	0	+	0	0
Western Toad	2	-	-	-	-	0	0	0	0
Pacific Treefrog	2	-	-	-	-	0	0	0	0
Red-legged Frog	2	-	-	-	-	0	0	0	0
Oregon Ensatina	4	-	-	-	?	0	+	0	0
Western Redback Salamander	4	-	-	-	?	0	+	0	0
Clouded Salamander	4	-	-	-	?	0	+	0	0
REPTILES									
Painted Turtle	3	0	0	0	?	0	0	0	0
Common Garter Snake	3	0	0	0	0	0	0	0	0
Western Terrestrial Garter Snake	3	0	0	0	0	0	0	0	0
Western Skink	3	-	-	-	?	0	+	0	0
Sharptail Snake	5	-	-	-	0	0	0	0	0
Northwestern Garter Snake	5	+	-	-	0	0	0	0	0
Northern Alligator Lizard	5	+	-	-	0	0	0	0	0

- Negative effect.
+ Positive effect.
0 No appreciable effect.
? Affect questionable; unable to hypothesize with available information.

Information presented is a synthesis of available information and current hypotheses (Appendix 13.5). Harestad (pers. comm.) and Orchard (pers. comm.) were consulted.

APPENDIX 13.7 Research priority ranking of species

SPECIES	Geographic Extent Van Is	Geographic Extent B.C.	Susceptibility	"Value"	Infor	Total	Priority Ranking
AMPHIBIANS							
Northwestern Salamander	1	2	3	1	1	8	3
Long-toed Salamander	3	1	2	1	1	8	3
Pacific Treefrog	1	2	2	1	1	7	4
Western Toad	1	1	2	1	1	6	4
Red-legged Frog	1	3	3	1	1	9	3
Western Redback Salamander	1	3	3	1	2	10	2
Oregon Ensatina	3	3	3	1	2	12	1
Clouded Salamander	2	3	2	1	2	10	2
Roughskin Newt	1	2	3	1	2	9	3
REPTILES							
Painted Turtle	3	2	3	1	1	10	2
Northern Alligator Lizard	2	3	1	1	1	8	3
Northwestern Garter Snake	1	3	1	1	2	8	3
Western Terrestrial Garter Snake	1	1	2	1	2	7	4
Common Garter Snake	1	1	2	1	2	7	4
Sharptail Snake	3	3	3	1	3	13	1
Western Skink	3	3	3	1	3	13	1

Geographic Extent: Wide = 1 Narrow = 3
Susceptibility (Impact): Low = 1 High = 3
"Value" (Fish & Wildlife Objective): Low = 1 High = 3
Information Quantity: High = 1 Low = 3
Priority Ranking: T = 12,13 R = 1 T = 8,9 R = 3
T = 10,11 R = 2 T = 6,7 R = 4

APPENDIX 13.8 Personnel contacted

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